

**A NEUTRAL TANDEM TELECOMMUNICATIONS NETWORK PROVIDING
TRANSITING, TERMINATING, AND ADVANCED TRAFFIC ROUTING
SERVICES TO PUBLIC AND PRIVATE CARRIER NETWORKS**

5 BACKGROUND OF INVENTION

FIELD OF THE INVENTION

The present invention relates generally to a telecommunications system for providing a neutral metropolitan area tandem switch network independent of the incumbent local exchange carriers and, in particular, to a system that bypasses the incumbent local exchange carrier tandem switch by creating a higher level in the switching hierarchy above the current RBOC tandems with respect to switching carrier traffic between carriers and switching and transporting traffic between the carriers and the local exchange carrier (LEC) metropolitan central offices and the LEC Advanced Traffic Routing Services.

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DESCRIPTION OF THE PRIOR ART

As the wireline and wireless telephone industry has evolved into a competitive market over the past two decades, one segment of the market has largely remained unchanged, namely, the manner in which traffic is routed into and out of a metropolitan region and between carriers serving those regions. In such cases, a LEC tandem network continues to be used. As will be explained below, this situation is a limitation to the continued expansion of the wireline and wireless telephone industry. An improved method and apparatus for routing such traffic is desired.

One segment of the wireline and wireless telephone industry that has had explosive growth since the divestiture of AT&T has been wireless carriers. Traditionally, the Regional Bell Operating Companies (RBOCs) held one of the two original wireless (cellular) licenses in each serving area as a result of their incumbent local exchange carrier (LEC) status. As a duopoly, there was not much rate competition in the early years of cellular service, so it was easy for the wireless competitor of an RBOC in a market to pass on any interconnection fee charged by the RBOC. As additional overlapping wireless networks have developed, such as Nextel and personal communications services ("PCS"), and the market grew increasingly competitive, challenges with interconnecting with the RBOC local monopoly networks on reasonable terms increased. In the development of the Telecommunications Act of 1996, competitive wireless carriers sought and received LEC interconnection protection similar to that secured by the competitive local exchange carriers (CLECs). As the FCC continues to make available additional frequencies for wireless carriers and as digital advancements improve wireless network capacity, many industry observers feel that wireless networks hold the first real potential for completely substituting for wireline RBOC local services. But such wireless networks will still have to interconnect with the RBOC wireline local network for sending and receiving traffic to and from RBOC wireline customers. Thus, to the extent the RBOCs make such interconnection difficult to achieve on a timely or uneconomic basis, the RBOCs will preserve their local monopoly status. History has shown that this is precisely the leverage the RBOC seeks to exercise in confronting competition.

Most long distance carriers passing traffic into and out of a metropolitan region do so at LEC tandems serving the region. The LEC charges the long distance carriers both tandem switching and tandem transport between the tandem and the local central office originating or terminating the call. Thus, tandem-related access charges payable to the

incumbent LECs are incurred. Access charges for tandem and central office switching and transport paid to LECs by the long distance carriers for the origination of calls by and termination of calls to RBOC customers, depending on a call's duration and cost per minute, constitute upwards of 40% of the overall cost of the long distance call. In addition, the Telecommunications Act of 1996 allows the RBOCs to apply for entry into the long distance market. The FCC has granted some of these applications, and it is expected to grant significantly more shortly. Thus, the long distance carriers, like the CLECs and wireless carriers, now face the challenge of both competing with the RBOCs while paying fees for accessing their network.

10 With respect to wireline or wireless carriers providing local calling in a metropolitan area, these carriers traditionally interconnect their networks as well to the LEC network at the LEC tandems, as opposed to establishing connections to every central office served by the tandems, which can easily run between 20 and 50 central offices for each tandem in a metropolitan area. When terminating a local call to a RBOC local service customer, these competitive wireline and wireless carriers, similar to the long distance carriers, are charged tandem switching and transport between the LEC tandem and the terminating local central office. Depending on the LEC retail local calling plan, the rates for tandem switching and termination charged competitive carriers on a per call basis for terminating a call to a LEC local service customer can exceed the retail rate charged a LEC customer for making a similar call, thus making competing with the LEC extremely uneconomic. This vestige of the RBOCs' past legal monopoly makes it more difficult for competitive carriers by providing the RBOCs with a cross-subsidy that can be used to compete against the CLECs. While in theory the payment for terminating a call is reciprocal, because the RBOC started with nearly 100% market share, it will be years before the RBOC's face a material financial exposure for such terminating charges to be

paid to CLECs, whereas CLECs view such charges as a barrier to entry and many have structured their networks and business plans in an attempt to minimize the impact of such fees. Moreover, to the extent a competitor is dependent on the LEC to be responsive in providing access to a portion of its network, that competitor risks its success. For
5 example, there have been reports of the RBOCs not sufficiently growing their tandem networks to meet the capacity required by new competitive carriers. As a result, the competitors risk providing a deteriorating level of service (e.g., a high rate of busy signals) or incurring uneconomic network deployments to circumvent tandem bottlenecks and connect directly to high traffic RBOC central offices.

10 This dependence by competitive carriers on the RBOC tandem networks is exacerbated by the fact that not only are the competitors using the tandems to route traffic between the RBOC network and their networks, but also the RBOC tandems have become a point at which overlapping networks in a metropolitan area interconnect. Thus, the RBOC tandems by default have become the points at which competitors route traffic
15 amongst themselves (transit traffic). Just as with traffic that terminates to customers of the RBOC, the RBOC is paid a fee by the competitive carriers for carrying this transit traffic even when an RBOC customer is not the called party. As a result, as competitors gain market share against the RBOC and exchange between themselves, the traffic really never leaves the tandem network; it continues to ride the RBOC network as transit traffic. These
20 transit fees, of course, act to cross-subsidize the RBOC in its competition with these competitive networks. However, the RBOCs have little interest in supporting such traffic (i.e., traffic passing between two competitors) with capital improvements, prompt customer service and order fulfillment. Indeed, the RBOCs have a disincentive to support such traffic, because deteriorating the quality of such transiting traffic could lead
25 customers of a competitive carrier to return to the RBOCs as retail customers. The present

alternative for competitive carriers seeking to exchange traffic between each other without going through the RBOC is for the competitive carriers to directly connect facilities between each other. Because of the varying amounts of traffic between such carriers as well as the traffic imbalance and the large and ever changing number of such carriers, this

5 would be prohibitively uneconomic.

With its entrenched monopoly status, the RBOC are generally free to dictate the various technical interconnection requirements for metropolitan area networks needing to interconnect with the RBOC. These interconnection requirements, in addition to the fees charged for interconnection, increase substantially the costs for carriers to interconnect

10 with the RBOC. Most challenging, the RBOC requires all carriers interconnecting with its network to do so on technical specifications dictated not by the advances in the market for technology, but by the legacy technical infrastructure of the RBOC circuit switch network. As a result, carriers with advanced, high capacity networks have to reduce their networks' efficiency each time they interconnect with the RBOC network. The following is an

15 example of the types of costly, duplicative, and complex interconnection requirements facing a metropolitan CLEC needing to connect with the local RBOC to serve a metropolitan region. Wireless carriers and, to a lesser extent, long distance carriers (because they do not provide local calling, but only require interconnection for originating and terminating long distance calls) face a similar maze of complexity and cost when

20 interconnecting with the RBOC:

- As commonly prescribed by the interconnection requirements between RBOCs and CLECs, at least five (5) types of trunk groups must be planned, transported and terminated for each CLEC switch interconnected in an RBOC-served metropolitan area:

Trunk Group 1 - Dedicated Local and dedicated IntraLATA Trunk Group(s) in
Each Local Exchange Area

Trunk Group 2 - InterLATA (Meet Point) Trunk Group routes to Access Tandem

Trunk Group 3 - E911 Trunk Group to primary and redundant E911 Tandems

5 Trunk Group 4 - High Volume Call In (HVICI) / Mass Calling (Choke) Trunk
Group routes to HVCI Tandem

Trunk Group 5 - Operator Services/Directory Assistance Trunk Group(s) routes to
OS/DA Tandem

As the following figures show, these trunking requirements rapidly become
10 complex, redundant, and costly.

- Figure 1a Trunk Group 1a: A Single, Separate Local Tandem, Access Tandem. For
each RBOC Local Tandem in a metropolitan area, a separate transport facility must be
connected to carry local calls originated in that local area for termination to RBOC
customers in that local area. For each Access Tandem in a metropolitan area, a
15 separate transport facility must be established for IntraLATA calls originated in that
LATA for termination to RBOC customers in that LATA.
- Figure 1b Trunk Group 1b: Combined Local and Access Tandems. In some situations,
an RBOC may have a tandem switch functioning as a combined Local and Access
Tandem. In those situations, a CLEC may combine local and IntraLATA traffic on the
20 same transport facility to the combined Local and Access Tandem, but the CLEC must
still (as described in Figure 4 below) establish a separate transport facility just for
Trunk Group 2, InterLATA traffic, even though it is terminating at the same combined
Local and Access Tandem.
- Figure 2 Multiple Tandems in a Metropolitan Area: Within each of these 5 trunk
25 groups, additional separate trunks may be required based on growth and the number of

tandems established by the RBOC. For example, in a large metropolitan area, such as the Chicago metropolitan area, there are currently eight combined Local and Access Tandems in five separate locations, each serving specific Local Exchange Areas. As a result, a CLEC serving the Chicago metropolitan area must establish a Trunk Group 1b connection for each of the eight tandems in the metropolitan area. Those skilled in the art should note that this is an example of the tandem interconnection required by Ameritech in Chicago LATA 357, and that the other LECs may require slightly different processes for the same purpose.

- Figure 3 RBOC Interconnection Rules Increase Cost: For Local Trunk Groups in each Local Exchange Area, the RBOC often establishes interconnection requirements that increase costs and complexity further, providing for example that:
 - Inter-Tandem switching is not allowed—i.e., a CLEC cannot pass traffic through one tandem to reach another tandem even in the event of overflow, but must have multiple dedicated tandem connections to each tandem.
 - Additional dedicated trunks can be required—for example, where traffic from a CLEC switch to specific RBOC Central Office or end office reaches a quantity to support, in the RBOC's opinion, a dedicated facility between the CLEC and the RBOC the Central Office (e.g., 24 or more trunks) a dedicated local trunk group shall also be established by the CLEC to the RBOC End Office (EO), thus causing the CLEC to incur additional port, transport and planning costs.
- Figure 4 Trunk Group 2 - InterLATA (Meet Point) Trunk Group 2: RBOCs require a separate facility for traffic passing between a CLEC's customers and long distance carriers connected to the RBOCs' tandem networks. Again, many RBOC requirements increase the cost and complexity of these connections:

- A dedicated InterLATA trunk group will be established for the transmission and routing of access traffic between CLEC's customers and long distance carriers sending or receiving long distance traffic from such customers via the RBOC Access Tandem.
- 5 • When the RBOC has more than one Access Tandem in a LATA, the CLEC must establish an InterLATA trunk group to each RBOC Access Tandem.
- In no event will the RBOC route traffic through more than one Tandem for connection to/from long distance carriers.
- Figure 5 Trunk Group 3 - E911 Trunk Group: To serve a metropolitan area, a CLEC
10 often is required to connect to multiple E911 Trunk Groups.
 - A dedicated trunk group for each calling area shall be established to each appropriate E911 Tandem within the local exchange area in which CLEC offers exchange service.
- Figure 6 Trunk Group 4 - High Volume Call In (HVCI) / Mass Calling (Choke) Trunk
15 Group: To serve a metropolitan area, a CLEC is also required to establish:
 - A dedicated trunk group to the designated Public Response HVCI/Mass Calling Network Access Tandem in each serving area
- Figure 7 Trunk Group 5 - Operator Services/Directory Assistance/Busy Line
20 Verification/EI Trunk Group(s): To serve a metropolitan area, a CLEC is also required to establish a dedicated trunk group to enable:
 - Busy Line Verification/Emergency Interrupt (BLV/EI)
 - Operator Assistance (0+, 0-)
 - Directory Assistance Call Completion (DACC)
 - 25 • Directory Assistance (DA)

Thus, at a minimum, a CLEC launching service in the Chicago metropolitan area must establish at least 20 separate T-1 trunk groups to support interconnecting to

Ameritech's 11 tandem switches in LATA 357. Figure 8 CLEC Costs Increase with

Interconnection Complexity: Figure 8 is an example of the cost incurred by the CLEC to
5 arrange for such interconnections. The cost includes: switch port costs on the CLEC's
switch, interconnection electronics for the network transport, network planning costs,
network transit costs to the interconnection points, multiplexing equipment at the
Tandem Central Office, switch port costs on the Tandem switch and usage based
switching fees charged by the RBOC to the CLEC. Because the RBOC limits the
10 interconnection speeds to those compatible with its legacy circuit switches, CLECs
incur unnecessary inefficiency in reducing their high bandwidth networks down to the
T-1 and DS-3 levels of interconnection speed prescribed by the RBOCs.

As shown in Figure 9, RBOC tandem interconnection trunking complexity
increases exponentially in a region as both the type of public and private carrier networks
15 increase (e.g., CLECs, wireless, cable television, long distance) and the absolute number
of such carriers increase. As traffic between these carriers grows, RBOC policies and
interconnection requirements continue to significantly increase planning complexity and
costs while reducing network efficiency. For example, RBOC interconnection rules
generally require that when transit traffic through a tandem from one CLEC to another
20 CLEC or wireless carrier requires 24 or more trunks, the CLEC shall establish a direct
trunk group between itself and the other CLEC or wireless carrier and not use the tandem
for traffic between such carriers. This requirement is similar to the requirement that a
CLEC establish dedicated trunks to an end office when the CLEC's traffic terminating to
the particular RBOC end office requires 24 or more trunks (see Figure 3). Establishing
25 such dedicated trunks adds additional costs for the competitive carriers by reducing switch

port capacity, adding transport management and electronics, and reducing tandem trunking efficiency. As CLEC and wireless carriers grow and dedicated facilities are required among such carriers and between such carriers and the RBOC end offices, the fundamental premise of utilizing a switch to interconnect these overlapping carrier networks is
5 destroyed, thus increasing cost for competitors. Without tandem switching, carriers would have to establish a mass of inefficient dedicated facilities as illustrated in Figure 10.

Above all, therefore, there exists a need to promote the development of a network alternative that breaks the cycle of relying on (and paying fees for) the RBOC network at the same time as competing with the RBOC. The more that neutral or independent
10 network components are available to carriers competing with the RBOCs, the more that the forces of competition will develop in the telecommunications market. Such facilities can promote competition by being both competitor neutral—i.e., not establishing unreasonable rates or practices in an effort to deter competition--and technology neutral—i.e., not preferring a specific technology for anti-competitive reasons.

15 However, to date, no solution has been proposed which would enable a company independent of the RBOCs to provide critical functions of the local telephone network on a broad scale at a competitive cost. There is thus a great need in the art for a system and method which would enable a company independent of the RBOCs to provide cost competitive components of the local telephone network, and hence enable meaningful
20 competition to the incumbent RBOCs in the local, wireless and long distance markets, without requiring a cost prohibitive infrastructure investment.

Accordingly, a LEC bypass technique is desired which promotes cost-effective competition with the LECs without requiring uneconomic significant infrastructure

investment. Embodiments of the present invention have been designed to meet this great need in the art.

In addition to reducing the dependence by carriers on its competitor, the LEC, embodiments of the present invention have also been designed to meet another great need
5 in the art, the need to significantly reduce the charges assessed by the LECs on most (i) long distance calls and (ii) local wireline (e.g., CLECs) and wireless (e.g., cellular) call terminations and the related traffic inefficiency, which cost consumers tens of billions of dollars each year.

Bypassing the LEC tandems and the associated inefficiencies could save the IXC,
10 CLECs and wireless carriers a significant portion of their service costs for providing telecommunications services and, once the associated savings are passed on to their subscribers, potentially save their customers billions of dollars each year. These cost savings from such LEC bypass will come in many forms. For example, the proprietor of the neutral tandem network (NTN) described below will be in a position to price their
15 services dramatically different from the current RBOC interconnection pricing. Today, the RBOC's disparate, inefficient tandem connections covering discrete geographic areas require carriers to establish multiple connections to pass traffic across a given metropolitan area; each connection requiring separate monthly connection fees. The RBOCs also require carriers to separate traffic based on traffic types, e.g., local traffic versus long
20 distance traffic. The proprietor of the NTN of the invention will enable carrier to terminate all such traffic using dramatically fewer connections, thus reducing carriers interconnection cost. Also, reducing interconnection points for terminating traffic will reduce the number of ports on carriers switches required to terminate such traffic, thus saving the carriers capital cost on their switches, which can be otherwise uses to create

revenue producing services. Finally, carrier customers will find that they need fewer engineering resources for managing their interconnections because the NTN of the invention simplifies the establishment of such connections by essentially outsourcing the carrier interconnection process.

5 Even more critical for the development of competition in the telecommunications market is the addition of a neutral provider of this important portion of the network. The lack of readily available, affordable, scalable local network assets is one of the primary obstacles to enhanced competition between the LECs and other potential entrants into the telecommunications marketplace.

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SUMMARY OF THE INVENTION

The above-mentioned needs in the art have been met by creating a neutral telecommunications network platform for providing tandem switching and transport services independent of the existing telephone network tandem infrastructure managed by the LECs. Those skilled in the art will appreciate that the techniques described herein permit the cost-effective creation of a hardwire platform of infrastructure and tandem switching capacity in many areas throughout the United States.

In particular, the present invention relates to a LEC bypass technology which provides a neutral tandem network ("NTN") by developing a series of reliable, centrally managed metropolitan voice interconnection gateways targeted at public and private wireline and wireless local and long distance carriers seeking to maximize the efficiency, performance, and reach of their networks. Carriers connecting to NTN telecommunications switching equipment will have their traffic routed to and from other carriers' networks in a manner that minimizes use of the LEC's metropolitan tandem switching network. This optimal routing of traffic among the multiplicity of networks that

comprise the telecommunications spectrum today (e.g., wireless, CLECs, IXC's) will enable greater network efficiency and increased reliability while reducing traffic termination costs and competitive risks.

While the last 25 years have seen an explosive growth in the number of competing telecommunications networks and technologies, from scores of overlapping wireless carriers and dozens of competing local carriers to hundreds of long distance networks, one critical aspect of the nation's PSTN has remained unchanged: The RBOC tandem. The RBOC tandems, which were initially designed to serve as an aggregation point for transporting RBOC traffic into and out of a metropolitan region, have by default also become both (1) the point at which competitive carriers exchange traffic among themselves (i.e., transit traffic) as well as (2) the sole portal for terminating calls to the RBOC end offices, or central offices (i.e., terminating traffic) and for reaching advanced services, such as E911, directory assistance and operator services. As a result, there are major bottleneck (both physical and competitive) and economic concerns in the present RBOC PSTN tandem network. Most importantly, the RBOCs, which previously held a legal monopoly in the local communications market, view nearly every user of its tandem services as a competitor. As such, the RBOCs are reluctant to commit the necessary resources and support to grow traffic at the tandems and to adapt, design and build the traffic interfaces and access facilities to meet the escalating needs of its competitors.

The NTN of the invention will provide a superior quality of transit and terminating service versus the RBOC's legacy PSTN circuit switched tandem network by enabling carrier customers to pass traffic among themselves (utilizing advanced technology interfaces) and around the PSTN RBOC tandems. Above all, NTN will create a better metropolitan network for exchanging traffic among carriers because its overriding

business purpose will be to facilitate the growth and development of its carrier customers within the region.

In a preferred embodiment, the NTN architecture will provide a reliable, scalable series of network access points by deploying an advanced tandem-level (Class 4) “soft switch” (as opposed to RBOC legacy circuit switch tandem technology) network architecture in each metropolitan market and establish multiple points of interconnection and switching throughout a metropolitan area. All of the NTN’s telecommunications switching equipment will be located in central office grade buildings located in the serving metropolitan area, equipped with battery backup and emergency generators, dual power sources, clocking, heating, ventilation and air conditioning systems. Carriers in theregion would connect into the network and be given access to the LEC’s network via the LEC’s switch, which would also be connected to the NTN. The NTN thus provides a higher level switching hierarchy above the current RBOC tandems.

15 BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and beneficial features of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, of which:

Figure 1a illustrates conventional single, separate local and access tandems.

20 Figure 1b illustrates conventional combined local and access tandems.

Figure 2 illustrates conventional use of multiple tandems in a metropolitan area:

Figure 3 illustrates the increased costs of conventional RBOC interconnection rules.

Figure 4 illustrates a conventional interLATA (Meet Point) trunk group that satisfies the RBOC's requirement of a separate facility for traffic passing between a CLEC's customers and long distance carriers connected to the RBOC's tandem networks.

Figure 5 illustrates a conventional E911 trunk group.

5 Figure 6 illustrates a conventional high volume call in (HVCI) / mass calling (Choke) trunk group.

Figure 7 illustrates a conventional Operator Services/Directory Assistance/Busy Line Verification/EI trunk group.

10 Figure 8 illustrates the increased complexity and costs to CLECs with interconnection complexity.

Figure 9 illustrates that RBOC tandem interconnection trunking complexity increases exponentially in a region as both the type of public and private carrier networks increase (e.g., CLECs, wireless, cable television, long distance) and the absolute number of such carriers increase.

15 Figure 10 illustrates that, without tandem switching, carriers would have to establish a mass of inefficient dedicated facilities.

Figure 11 illustrates a Neutral Tandem Network (NTN) in accordance with a preferred embodiment of the invention.

20 Figure 12 illustrates an example of the Neutral Tandem switching gateway in accordance with the invention providing packet based or TDM higher density interfaces to competitive carriers and TDM interfaces of all types to the LEC Tandem Network.

Figure 13 illustrates soft switch call processing whereby a call arrives over an NTN-connected carrier's transport to the NTN node or gateway.

25 Figure 14 illustrates a local call between customers of two NTN-connected CLECs using the NTN of the invention.

Figure 15 illustrates a local call between customers of two CLECs connected at the same remote switching node on the NTN of the invention.

Figure 16 illustrates a local call between customers of an NTN-connected CLEC and an NTN-connected wireless carrier using the NTN of the invention.

5 Figure 17 illustrates a local call between customers of an NTN-connected RBOC and an NTN-connected CLEC using the NTN of the invention.

Figure 18 illustrates a local call between customers of an NTN-connected CLEC and a CLEC that is not connected to the NTN of the invention.

10 Figure 19 illustrates a long distance call from a customer of an NTN-connected long distance carrier and an RBOC local service customer using the NTN of the invention.

Figure 20 illustrates a local call from a customer of an NTN-connected CLEC and an RBOC local service customer using the NTN of the invention.

Figure 21 illustrates a local call from a customer of an NTN-connected wireless carrier terminating to an RBOC local service customer using the NTN of the invention.

15 Figure 22 illustrates a 911 call from a customer of an NTN-connected CLEC in accordance with the invention.

Figure 23 illustrates a directory assistance call from a customer of an NTN-connected CLEC in accordance with the invention.

20 **DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS**

Figure 11 illustrates a Neutral Tandem Network (NTN) in accordance with a preferred embodiment of the invention. Preferably, the NTN architecture is engineered as a reliable, scalable series of network access points. The NTN will deploy an advanced
25 tandem-level (Class 4) "soft switch" (as opposed to RBOC legacy circuit switch tandem

technology) network architecture in each metropolitan market and establish multiple points of interconnection and switching throughout a metropolitan area. All of the NTN's telecommunications switching equipment will be located in central office grade buildings located in the serving metropolitan area, equipped with battery backup and emergency
5 generators, dual power sources, clocking, heating, ventilation and air conditioning systems. Thus, the NTN provides a Tandem access point for all carriers in the region.

Carrier customers with network connection facilities located within the building housing the main NTN telecommunications switching equipment for a metropolitan area may connect directly to NTN using multiple network interfaces (e.g., T-1, DS3, STS-1,
10 Optical, Gigabit/Fast Ethernet, ATM, TDM). The use of an advanced soft switch allows a greater variety of network interfaces than RBOC circuit switches, including newer digital packet switching based connections. Customers with networks connections outside the NTN main telecommunications switching location may access the NTN through remote NTN "on-ramps" or remote telecommunications switching equipment gateways
15 established at buildings in the metropolitan area. Such remote switches may also be located inside RBOC end offices or tandems, depending on interconnection rules and regulations. Each gateway or remote module on the NTN metropolitan network will have switching intelligence, thus enabling local switching among carriers interconnected at the remote site without the need to transport or backhaul traffic to the main switching center to
20 make such connections. Multiple switching modules and multiple connection points will provide back-ups in the case of failure of any single NTN telecommunications switching equipment or device. The NTN soft switch network architecture will be designed to grow as its carrier customers' traffic demands increase and as NTN adds new customers.

Unlike the RBOC tandem switch network, which requires dedicated connections to
25 each tandem in a metropolitan region and often multiple connections to each of those

tandems, the NTN will allow carriers to access an entire metropolitan region through a single connection. Unlike the RBOC tandem switches, which require carriers to scale down their high capacity networks to the narrow bandwidth capacity compatible with the RBOC legacy circuit switches, the NTN will further accommodate an entire spectrum of network interconnection specifications, from T-1 connections to fiber optic-feed OC-48 interfaces—e.g., “Fat Pipes,” as shown in Figure 11.

A key enabling technology of the NTN of the invention is the soft switch platform. “Soft switch” is an all-encompassing term for a next-generation communications system that employs open standards to create integrated networks with a decoupled service intelligence capable of carrying voice, video, and data traffic more efficiently than possible with existing circuit switches. The separation of policy-based call control and services from the underlying transport network and hardware is the key defining element of soft switches. Traditionally, circuit switches have combined all the functions necessary to handle telephone calls—switching, call control, signaling, services, routing, and provisioning—together into a single, proprietary piece of equipment. As a result, the PSTN powered by circuit switches delivers a constrained set of services based on connections limited to 64 kbps and tied directly to the telephone switching hardware. The migration from circuit-switched networks to packet/frame/cell-switched networks controlled by soft switches will transition the industry from a closed environment to open standards-based systems. Soft switches enable service consistency despite variations in the underlying media or transport networks or devices. Thus, decoupling the policy-based call routing allows carriers to both handle various network infrastructures (IP, ATM, TDM) on a call-by-call basis and to determine the best routing or path for such calls. Soft switches therefore allow the NTN to transport all types of traffic over a single core

network and to interface with such networks at dramatically higher densities (T-1, T-3, OC-3, OC-12) than that available in the current tandem network.

Figure 12 illustrates an example of the Neutral Tandem switching gateway in accordance with the invention providing packet based or TDM higher density interfaces to competitive carriers and TDM interfaces of all types to the LEC Tandem Network.

As a result of the separation of call control and hardware, soft switches also yield per port cost savings of 50% versus circuit switches and lower provisioning and maintenance costs. The per port cost savings should increase as a result of the soft switch's leveraging of what has become known as Moor's Law. It is expected that the performance of data components (at the same cost), which make up the bulk of the soft switch infrastructure, is doubling every 18 months, while the performance of voice components is doubling every 10 years. In addition, packet based infrastructure takes up much less physical space than traditional circuit switches. For example, while it takes 40 bays of equipment to handle 50,000 circuit-based calls, it takes only two 19" racks to hold the equivalent soft switch infrastructure handling the same number of calls.

The soft switch is therefore a software system that manages network devices to set up calls across IP, ATM, and circuit networks. The soft switch maintains network policy information on services, routing, and provisioning, and applies these policies to determine how calls should be handled.

Because of their software design, soft switches can utilize a wide range of standard hardware platforms to fit any size network. It may be replicated as required for high availability or to support very high call processing requirements. In case of a failure of the primary soft switch, the system can be designed to transparently transfer control to another soft switch without any impact on calls. The software-driven platform also allows essentially unlimited scalability and call-processing capability, unlike circuit switches that

are constrained from unlimited scaling by hardware-related bottleneck networks. Finally, the software foundation of the soft switch allows services and applications to be built using open APIs on standards-based platforms and developed on commercially available tools. Published APIs use existing standards, opening the carrier services market to a new
5 segment of developers who can — for the first time — build new caller services based on IP servers.

Figure 13 illustrates soft switch call processing. As illustrated, a call arrives over an NTN-connected carrier's transport to the NTN node or gateway (point "A" on Figure 13). The gateway notifies the soft switch (point "B" on Figure 13), providing the available
10 information about the call: calling number, number called, carrier, trunk group. The soft switch analyzes the call information according to NTN-defined service selection rules. The rules define the order in which the soft switch analyzes call attributes to determine provisioned services. For example, a particular called number may be associated with an end office in which the NTN has diverse routing options. The soft switch would analyze
15 the options and determine the optimal route—e.g., confirming that one path is utilized and thus choosing an alternative path (point "C" on Figure 13). The soft switch handles each provisioned service in turn, either performing itself or instructing the gateway to perform the service.

Sample call placement using the NTN of the invention will be described below
20 with respect to Figures 13-18.

As also shown in Figure 13, for transit call routing over the NTN, a customer of an NTN-connected long distance carrier goes off-hook at their premises, dials a long distance call—e.g., 1+area code+terminating telephone number. The call is routed by the serving local exchange carrier to the calling party's preferred long distance carrier's Point of
25 Presence ("POP"). At the POP, the long distance carrier's switch reads the area code and

first three digits of the terminating telephone number to determine the metropolitan area and tandem switch associated with the terminating telephone number and routes the call through its long distance network to the terminating POP serving that metropolitan area. Because the long distance carrier has connected the terminating POP to the NTN for that metropolitan area, the call is routed to the NTN for termination over the transport facility between the long distance carrier and the NTN. The call is received at the NTN with the terminating area code and telephone number. The NTN switch looks up the terminating telephone number using its SS-7 database link to determine the local carrier for terminating the call. Upon looking up the telephone number, the NTN determines that the terminating local carrier (e.g., CLEC) is also connected to the NTN, and the NTN switch routes the call over the transport connecting the CLEC to the NTN. The call then proceeds over the CLEC's network to its Class 5 switch, which translates the terminating telephone number into a local loop terminating at the called party's premise.

Figure 14 illustrates a local call between customers of two NTN-connected CLECs.

As illustrated, a customer of an NTN-connected CLEC 1 goes offhook at their premises and dials a local call—e.g., seven-digit terminating telephone number. The calling party's CLEC 1 switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the CLEC 1 determines that the terminating local carrier (e.g., CLEC 2) is also connected to the NTN. The call is then routed over the hardwire connection between CLEC 1 and the NTN switch. The NTN switch receives from CLEC 1 the call routing information and sends the call on to CLEC 2 over the hardwire connection between NTN and CLEC 2. CLEC 2's switch reads the traffic

routing information and the called party's telephone number and opens up the circuit to transmit the call to the called party.

Figure 15 illustrates a local call between customers of two CLECs connected at the same remote switching node on the NTN. As illustrated, a customer of an NTN-connected CLEC 1 goes off-hook at their premises and dials a local call—e.g., seven-digit terminating telephone number. The calling party's CLEC 1 switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the CLEC 1 determines that the terminating local carrier (e.g., CLEC 2) is also connected to the NTN. The call is then routed over the hardwire connection between CLEC 1 and the remote NTN switch. The remote NTN switch receives from CLEC 1 the call routing information, determines that CLEC 2 is also connected to the remote switch and sends the call on to CLEC 2 over the hardwire connection between the remote NTN switch and CLEC 2. CLEC 2's switch reads the traffic routing information and the called party's telephone number and opens up the circuit to transmit the call to the called party.

Figure 16 illustrates a local call between customers of an NTN-connected CLEC and an NTN-connected wireless carrier. As illustrated, a customer of an NTN-connected CLEC goes off-hook at their premises and dials a local call—e.g., seven-digit terminating telephone number. The calling party's CLEC switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the CLEC determines that the terminating carrier is a wireless carrier also connected to the NTN. The call is then routed over the hardwire connection between the CLEC and the

NTN switch. The NTN switch receives from the CLEC the call routing information and sends the call on to the wireless carrier over the hardwire connection between NTN and the wireless carrier. The wireless carrier's Mobile Telephone Switching Office ("MTSO") reads the traffic routing information and the called party's telephone number and sets up
5 the call for transmission to the called party.

Figure 17 illustrates a local call between customers of an NTN-connected RBOC and an NTN-connected CLEC. For trunking efficiencies, an RBOC may choose to utilize the NTN to transmit traffic terminating to carrier networks connected to the NTN. As illustrated, a customer of an NTN-connected RBOC goes off-hook at their premises and
10 dials a local call—e.g., seven-digit terminating telephone number. The calling party's RBOC local switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the RBOC determines that the terminating
15 local carrier (e.g., CLEC) is also connected to the NTN. The call is then routed over the hardwire connection between the RBOC and the NTN switch. The NTN switch receives from the RBOC the call routing information and sends the call on to the terminating CLEC over the hardwire connection between NTN and the CLEC. The CLEC's switch reads the traffic routing information and the called party's telephone number and opens up the
20 circuit to transmit the call to the called party.

Figure 18 illustrates a local call between customers of an NTN-connected CLEC and a CLEC that is not connected to the NTN. For trunking efficiency or overflow purposes, an NTN-connected CLEC may choose to route transiting traffic over NTN to a CLEC not hardwired connected to NTN. As illustrated, a customer of an NTN-connected
25 CLEC goes off-hook at their premises and dials a local call—e.g., seven-digit terminating

telephone number. The calling party's CLEC 1 switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the

5 CLEC 1 determines that the terminating local carrier (e.g., CLEC 2) is connected to an RBOC tandem connected to the NTN. The call is then routed over the hardwire connection between CLEC 1 and the remote NTN switch. The remote NTN switch receives from CLEC 1 the call routing information, determines that CLEC 2 is accessible through an RBOC tandem connected to the NTN and sends the call on to CLEC 2 over the hardwire

10 connection between the NTN and the terminating RBOC tandem. The RBOC tandem receives the routing information and sets up a connection over local access Trunk Group established by CLEC 2. CLEC 2's switch receives and translates the traffic routing information and the called party's telephone number and opens up the circuit to transmit the call to the called party.

15 Examples of terminating call routing to RBOC end offices over the NTN of the invention will now be illustrated with respect to Figures 19-21.

Figure 19 illustrates a long distance call from a customer of an NTN-connected long distance carrier and an RBOC local service customer. As illustrated, a customer of an NTN-connected long distance carrier goes off-hook at their premises, dials a long distance

20 call—e.g., 1+area code+terminating telephone number. The call is routed by the serving local exchange carrier to the customer's preferred long distance carrier's Point of Presence ("POP"). At the POP, the long distance carrier's switch reads the area code and first three digits of the terminating telephone number to determine the metropolitan area and tandem switch associated with the terminating telephone number and routes the call through its

25 long distance network to the terminating POP serving that metropolitan area. Because the

long distance carrier has connected the terminating POP to the NTN for that metropolitan area, the call is routed to the NTN for termination over the transport facility between the long distance carrier and the NTN. The call is received at the NTN with the terminating area code and telephone number. The NTN switch looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call. Upon looking up the telephone number, the NTN determines that the RBOC is the terminating local carrier and that the RBOC end office serving the called telephone number is connected to the NTN. The NTN switch then routes the call over the transport connecting the NTN to the terminating end office. The call then proceeds over an interconnection facility into the RBOC's network to its Class 5 switch, which translates the terminating telephone number into a local loop terminating at the called party's premise.

Figure 20 illustrates a local call from a customer of an NTN-connected CLEC and an RBOC local service customer. As illustrated, a customer of an NTN-connected CLEC goes off-hook at their premises and dials a local call—e.g., seven-digit terminating telephone number. The calling party's CLEC switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the CLEC determines that the RBOC terminating local end office is also connected to the NTN. The call is then routed over the hardwire connection between CLEC and the NTN. The call is received at the NTN switch with the terminating telephone number and routing information showing the RBOC is the terminating local carrier and that the RBOC end office serving the called telephone number is connected to the NTN. The NTN switch then routes the call over the transport connecting the NTN to the terminating RBOC end

office. The call then proceeds over an interconnection facility into the RBOC's network to its Class 5 switch, which translates the terminating telephone number into a local loop terminating at the called party's premise.

Figure 21 illustrates a local call from a customer of an NTN-connected wireless carrier terminating to an RBOC local service customer. As illustrated, a customer of an NTN-connected wireless carrier dials a local call—e.g., seven-digit terminating telephone number. The calling party's MTSO switch reads the terminating telephone number to determine that it is a local area call and looks up the terminating telephone number using its SS-7 database link to determine the local carrier for the terminating the call and routing path for terminating the call. Upon looking up the telephone number, the wireless carrier determines that the RBOC terminating local end office is also connected to the NTN. The call is then routed over the hardwire connection between wireless carrier and the NTN. The call is received at the NTN switch with the terminating telephone number and routing information showing the RBOC is the terminating local carrier and that the RBOC end office serving the called telephone number is connected to the NTN. The NTN switch then routes the call over the transport connecting the NTN to the terminating RBOC end office. The call then proceeds over an interconnection facility into the RBOC's network to its Class 5 switch, which translates the terminating telephone number into a local loop terminating at the called party's premise.

Examples of Advanced Traffic Call Routing over the NTN of the invention will now be described with respect to Figures 22 and 23.

Figure 22 illustrates a 911 call from a customer of an NTN-connected CLEC. As illustrated, a customer of an NTN-connected CLEC goes off-hook at their premises and dials 911. The calling party's CLEC switch reads the terminating telephone number to determine that it is a 911 call and looks up the terminating telephone number using its SS-

7 database link to determine the routing path for terminating the call. Upon looking up the telephone number, the CLEC determines that the relevant 911 access tandem is connected to the NTN. The call is then routed over the hardwire connection between CLEC and the NTN. The call is received at the NTN switch with the terminating 911 telephone number and routing information showing the RBOC 911 access tandem is connected to the NTN. The NTN switch then routes the call over the transport connecting the NTN to the terminating RBOC 911 access tandem. The call then proceeds over an interconnection facility from the 911 access tandem into the RBOC's network to the Class 5 switch serving the local emergency agency for the calling party, which translates the 911 number into a local loop terminating at the emergency agency's premise.

Figure 23 illustrates a directory assistance call from a customer of an NTN-connected CLEC. As illustrated, a customer of an NTN-connected CLEC goes off-hook at their premises and dials 411. The calling party's CLEC switch reads the terminating telephone number to determine that it is a 411 call and looks up the terminating telephone number using its SS-7 database link to determine the routing path for terminating the call. Upon looking up the telephone number, the CLEC determines that the relevant 411 directory assistance access tandem is connected to the NTN. The call is then routed over the hardwire connection between CLEC and the NTN. The call is received at the NTN switch with the terminating 411 telephone number and routing information showing the RBOC 411 directory assistance access tandem is connected to the NTN. The NTN switch then routes the call over the transport connecting the NTN to the terminating RBOC 411 access tandem. The call then proceeds over an interconnection facility from the 411 directory assistance access tandem into the RBOC's network to its directory assistance center.

Those skilled in the art will appreciate that the NTN platform of the invention permits a number of system enhancements. For example, the soft switch platform may incorporate an enterprise communications server application which will allow voice, data, video, wireless, and other types of communications between end-points such as voice
5 terminals, data terminals, computers, transceivers, and the like on a private or virtual private network basis.

Although exemplary embodiments of the invention have been described in detail above, those skilled in the art will readily appreciate that many additional modifications are possible in the exemplary embodiment without materially departing from the novel
10 teachings and advantages of the invention. For example, those skilled in the art will appreciate that in each case the T1 data lines described may be T1 or greater high capacity data lines (e.g., T3, OC3, OC12). In addition, those skilled in the art will appreciate that other telephone equipment besides a soft switch may be used to provide the switching and tandem. The remote and main switching terminals may use any of a number of wired or
15 wireless protocols. Accordingly, these and all such modifications are intended to be included within the scope of this invention as defined in the following claims.